EnviroLogic Resources, Inc.
Consulting Environmental & Water Resources Scientists

May 17, 2006
10077.012

Oregon Department of Environmental Quality
Northwest Region
2020 SW Fourth Avenue
Suite 400
Portland, Oregon 97201-4987

VIA Email/First Class

Subject: **Preliminary Results for Sediment, Water Column Sampling, and Bioassay Ecological Risk Assessment**
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon
DEQ ECSI File #2277

Dear Ms. Coates:

Enclosed are four copies of the above-referenced document. This document is being submitted to you on behalf of the Astoria Area-Wide Cooperating Parties.

Please call me at (503)768-5121 if you have any questions or comments.

Sincerely,
EnviroLogic Resources, Inc.

Thomas J. Calabrese, RG, CWRE
Principal/Hydrogeologist
Project Manager

cc: Distribution list attached

ASTORIA AREA-WIDE PETROLEUM SITE
Distribution List

1 Anna Coates, DEQ Project Manager, Site Response
1 Don Haagensen, Attorney for Port of Astoria
1 Peter Gearin, Port of Astoria
1 Tom Calabrese, *EnviroLogic Resources, Inc.*, Consultant for PoA and AAW PRP Group
1 Max Miller, Tonkon Torp, Attorney for McCall Oil and Chemical Corporation
1 Ted McCall, McCall Oil and Chemical Corporation
1 John Edwards, Anchor Environmental, LLC, Consultant for McCall Oil and Chemical Corp
1 Cary E. Bechtolt, Niemi Oil Company
1 Jeff Kray, Marten Law Group, PLLC, Attorney for Niemi Oil Company
1 Kurt Harrington, AMEC, Inc., Consultant for Niemi Oil Company
1 Ed Platt, Shell Oil Company
1 Rick Glick, Davis Wright Tremaine, Attorney for Shell Oil Company
1 Leon Lahiere, Hart Crowser, Consultant for Shell Oil Company
1 Brian Harris, Harris Enterprises
1 Larry Vandermay, Flying Dutchman
1 David Bartz & Laura Maffei, Schwabe Williamson & Wyatt, Attorney for Flying Dutchman
1 Hong Hyunh, Miller Nash, Attorney for Harris Enterprises
1 Lon Yandell, Kleinfelder, Consultant for Harris Enterprises
1 Richard Delphia, Delphia Oil Company
1 Chuck Smith, Attorney for Delphia Oil Company
1 Alistaire Clary, Maul Foster Alongi, Consultant for Delphia Oil Company
1 Darin Rouse, ChevronTexaco Products Company
1 Soniya Ziegler, Attorney for ChevronTexaco Products Company
1 Gerry Koschal, SAIC, Consultant for ChevronTexaco Products Company
1 Brian Jacobson, Qwest Communications International, Inc.
1 David Bledsoe, Perkins Coie LLP, Attorney for Qwest Communications International, Inc.
1 Donna LaCombe, Tetra Tech EM, Inc., Consultant for Qwest Communications International
1 Anita W. Lovely, Lovely Consulting, Inc., Consultant for Exxon Mobil Corporation

Kennedy/Jenks Consultants

Engineers & Scientists

200 S.W. Market Street, Suite 500
Portland, Oregon 97201-5715
503-295-4911
503-295-4901 (Fax)

15 May 2006

Mr. Tom Calabrese, RG, CWRE
Principal/Hydrogeologist
EnviroLogic Resources, Inc.
P.O. Box 80762
Portland, Oregon 97280-0762

Subject: Preliminary Results for Sediment, Water Column Sampling, and Bioassay Results
Ecological Risk Assessment
Astoria Area-Wide Site
K/J 0592004.00

Dear Mr. Calabrese:

Kennedy/Jenks Consultants (Kennedy/Jenks) prepared this letter to present preliminary results and findings for the surface sediment and water column sampling and subsequent sediment bioassay testing conducted on 26 January 2006 for the ecological risk assessment (ERA) at the Astoria Area-Wide site in Astoria, Oregon (Site). The sampling was conducted per Kennedy/Jenks' 22 September 2005 work plan, approved by the Oregon Department of Environmental Quality (DEQ) in their 8 December 2005 comment letter. Responses to comments on the ERA work plan were provided to DEQ in a Kennedy/Jenks letter dated 12 January 2006. Preliminary sediment analytical results were provided to DEQ on 3 March 2006 along with a request for Bioassay Reference Sediment Selection Approval. A DEQ response letter was received on 6 April 2006 along with additional information on reference sediment use regarding a separate project (UNOCAL Phase 2 Columbia River Sediment Investigation) dated 16 March, 2006.

Field Sampling

Kennedy/Jenks conducted a surface sediment and surface water investigation at the Site on 26 January 2006. Divers from Northwest Underwater Construction (NWUC) of Vancouver, Washington, collected sediment samples and provided the sampling vessel for the investigation. Kennedy/Jenks personnel collected mid-water column samples from the NWUC sampling vessel. Station positioning, sampling methods, sample handling and custody, decontamination procedures, laboratory chemical and biological analyses, and field documentation were performed in a manner consistent with the Kennedy/Jenks (2005) ERA work plan. The only deviation from the DEQ-approved work plan was the use of a surface-deployed water sampler versus diver collection of water column samples.

Station Location

Kennedy/Jenks personnel used a handheld global positioning system (GPS) Garmin GPSMAP 76S with a stated accuracy of ± 3 meters to obtain latitude/longitude coordinates for the seven sediment sampling stations (five Site and two reference) and five surface water sampling stations outlined in the Kennedy/Jenks (2005) work plan. Figure 1 illustrates the location of the reference stations. Figure 2 illustrates the location of the Site sediment/surface water stations.

Surface water samples SW-100, SW-101, SW-102, and SW-104 were collected from co-located stations with sediment samples SD-100, SD-101, SD-102, and SD-104, per the work plan. Table 1 summarizes the sampling station coordinates, approximate depth to mudline, approximate tidal height, and corrected depth to mudline (tide corrected to Columbia River Datum [CRD]).

Sampling Methods and Documentation

Surface Water Sampling

At each surface water sampling station, an approximate depth sounding was first obtained with a graduated lead line. One deviation from the work plan was the use of a surface-deployed water column sampler, as opposed to the proposed diver collection method of water samples. The water column samples were collected at each co-located station prior to collection of surface sediment samples. These procedures ensured minimal disturbance of the sediment bottom and undesirable turbidity in the water column samples that could potentially bias analytical results.

Kennedy/Jenks staff deployed a 2.2-liter capacity Van Dorn horizontal water sampler to the midpoint of the water column. A weighted messenger was released to trigger water sample capture at the appropriate depth. Upon retrieval of the sampler, surface water samples were placed directly into precleaned laboratory containers, labeled, and placed into coolers with ice for transportation to Columbia Analytical Services (CAS), Kelso, Washington. Chain-of-custody procedures were followed as stated in the work plan during the course of sampling and analysis. The Van Dorn sampler was decontaminated in between stations by thoroughly scrubbing the unit with a soap and water solution, followed by a deionized water rinse.

Sediment Sampling

Upon arriving at the sediment sampling station, a NWUC diver was deployed. The diver descended to the mudline and noted any visual observations. The diver collected the upper 10 cm of sediment from below the mudline using a handheld core tube. Both ends of the tube were capped to prevent loss of material. Upon returning to the surface, the sediment was emptied into a stainless steel container. Multiple cores were collected at each sampling station to obtain the required sediment volumes for both chemical and biological testing.

For all sampling stations, sediment was thoroughly homogenized by hand using a stainless steel spoon. Samples were placed into precleaned laboratory containers, labeled, and placed

into coolers with ice for transportation to CAS. Chain-of-custody procedures were followed as stated in the work plan during the course of sampling and analysis. Decontamination of core tubes, stainless steel spoons, and the stainless steel container was accomplished between stations by thoroughly scrubbing the equipment with a soap and water solution, followed by a deionized water rinse.

Several surface sediment samples contained notable petroleum odors. These samples were located in the southeast corner of Slip 2, including SD-100, SD-101, SD-102, and SD-103.

Surface Water Quality Results

Table 2 summarizes the results of the five water column samples (SW-100, SW-101, SW-102, SW-104, SW-105) collected from within Slip 2. Per the Kennedy/Jenks (2005) work plan, concentrations of polynuclear aromatic hydrocarbons (PAHs) in surface water were compared to U.S. Environmental Protection Agency (EPA) final chronic values (FCVs) (EPA 2003). Concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) were compared to DEQ aquatic screening level values (SLVs) (DEQ 2001). No FCVs or SLVs were exceeded in any of the samples. Because surface water concentrations were below FCVs or SLVs, we conclude that petroleum constituents in surface water do not pose an unacceptable risk to pelagic aquatic receptors.

Surface Sediment Quality Results

The following sections present the results of surface sediment sampling conducted at the Site.

Sediment Physical Characteristics

All seven surface sediment samples were analyzed for the full list of Sediment Management Standards (SMS) chemicals and six conventional parameters. Sediment grain size, total organic carbon (TOC), total solids, total volatile solids (TVS), ammonia, and total sulfides are summarized on Table 3. A summary of the laboratory chemical analytical results compared to DEQ (2001) marine/estuarine sediment SLVs is presented on Table 4.

Sediment samples collected at the site were predominantly silt and clay grain sizes (Table 3). All sediment samples, including the two reference samples, contained at least 70 percent fine-grained particles, with the exception of SD-102 (50.5 percent silt/clay). Levels of TOC and TVS were highest in SD-102. Ammonia as nitrogen, total solids, and total sulfide were lowest in SD-102. No other anomalies were observed in the sediment physical data.

Sediment Chemical Analytical Results

Sediment chemical analytical results are summarized on Table 4. Several sediment samples contained multiple constituents exceeding DEQ marine/estuarine sediment SLVs. All samples (including reference samples) collected had exceedances of SLVs for the metals copper and zinc, likely due to high naturally occurring background concentrations in sediments. Samples

SD-104, REF-EBB and REF-YB had slight exceedances of the DEQ SLV for mercury, with enrichment ratios less than two. Enrichment ratio is calculated by dividing the chemical concentration by the appropriate SLV for that chemical.

Concentrations of petroleum constituents in samples SD-100, SD-101, and SD-102 were sufficiently high to warrant dilution by CAS prior to analysis (Table 4). Exceedances of DEQ SLVs for the light PAHs (LPAHs) naphthalene, 2-methylnaphthalene, phenanthrene, and anthracene were observed in samples SD-101, SD-102 and SD-103. Exceedances of DEQ SLVs for the heavy PAHs (HPAHs) fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(a)pyrene, and dibenz(a,h)anthracene were observed in samples SD-100, SD-101, SD-102, and SD-103. Exceedances of DEQ SLVs for total LPAHs and total PAHs were also observed in samples SD-101, SD-102, and SD-103. Exceedance of the DEQ SLV for total HPAHs was observed in samples SD-100, SD-101, SD-102, and SD-103.

Concentrations of total polychlorinated biphenyl (PCB) Aroclors in samples SD-100, SD-101, and SD-102 also exceeded the DEQ marine/estuarine SLV.

The reporting limits for several analytes were elevated in samples SD-100, SD-101, and SD-102. The sample extracts were diluted by a factor of 100 prior to analysis because of relatively high levels of target (i.e., petroleum) analyte concentrations. Because of the dilution in samples SD-100, SD-101, and SD-102, the reporting limits for 12 compounds exceeded their respective SLVs despite yielding non-detect results: acenaphthalene; acenaphthene; fluorene; hexachlorobenzene; dimethyl phthalate; diethyl phthalate; di-n-butyl phthalate; dibenzofuran; hexachlorobutadiene; N-nitroso-diphenylamine; pentachlorophenol; benzoic acid.

Sediment Bioassay Testing Preliminary Results

As part of the Level III baseline ERA, bioassay testing was completed on the five surface sediment samples from Slip 2 and both reference surface sediment samples. Northwestern Aquatic Sciences (NAS) of Newport, Oregon conducted the sediment bioassay tests. The suite of proposed marine/estuarine biological tests, selected according to the Dredged Material Evaluation Framework (DMEF) (Corps et al. 1998) for the Lower Columbia River Management Area (LCRMA), was as follows:

- Acute 10-day amphipod mortality test
- Chronic 20-day juvenile polychaete survival/growth test
- Acute 48-hour larval echinoderm/bivalve mortality/abnormality test.

The preliminary results of the three marine sediment bioassay tests are presented in Tables 5, 6, and 7, respectively. NAS has not yet conducted statistical interpretation of the bioassay results. Kennedy/Jenks completed preliminary interpretation of the results based on criteria presented in the DMEF.

Acute Amphipod Mortality Bioassay

Test samples SD-100, SD-101, SD-102 yielded 100 percent amphipod mortality, and test sample SD-103 yielded 61 percent amphipod mortality (Table 5).

The low interstitial salinity (i.e., 1 to 7 parts per thousand [ppt]) found in the sampled Site and reference sediments may have caused initial environmental stress to the test organisms unrelated to chemical toxicity, even though interstitial salinity by the end of the test was within normal estuarine range (i.e., 25 to 29 ppt) (Table 5). This low interstitial range in the bulk sediment may partially explain the poor performance criteria for organisms (neither reference sediment met performance criteria for the amphipod bioassay) in the relatively clean reference sediment.

Personal discussion with Mark Siipola of the Portland District U.S. Army Corps of Engineers indicated that other dredged material characterization projects recently conducted in the vicinity of the Site (East Astoria Boat Basin and Skipanon Channel) also found similar low salinity and similar issues with the Polychate Growth and Acute Larval Bioassays as described below (Mark Siipola, pers. comm. 4 May 2006).

Chronic Juvenile Polychaete Survival/Growth Bioassay

All samples appeared to pass the “one-hit” criteria for growth and survival in the bioassay (Table 6). Reference sample REF-EBB did not meet performance criteria for growth, as the growth rate was less than 80 percent of the negative control per DMEF. Low interstitial salinity may also explain the poor performance of the juvenile polychaete growth in reference sediment.

Acute Larval Echinoderm/Bivalve Mortality/Abnormality Bioassay

Sample SD-101 appeared to fail the “one-hit” criteria for normalized combined mortality and abnormality (NCMA) in the bioassay, as the test NCMA exceeded the reference NCMA plus 30 percent (Table 7). Both reference samples (REF-EBB and REF-YB) did not meet performance criteria for NCMA, as the NCMA in both samples exceeded the seawater control plus 35 percent standard. The low salinity in the bulk sediments may also explain the poor performance of the larval organism with respect to mortality and abnormality.

Conclusions

Kennedy/Jenks proposed in a letter to EnviroLogic Resources, Inc. dated 3 March 2006 using REF-EBB as reference sediment in the bioassay testing program. The letter was forwarded to DEQ, and comments on the reference sediment selection were received, dated 4 April 2006. In its comment letter, DEQ required the use of both reference samples in the testing program. We recommend scheduling a meeting as soon as possible between Kennedy/Jenks, EnviroLogic Resources, Inc., and DEQ to discuss the low salinity issue in light of the preliminary bioassay results and clarify the reference sediment request by DEQ.

References

Corps et al. 1998. Dredged Material Evaluation Framework, Lower Columbia River Management Area. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Washington State Department of Ecology, Oregon Department of Environmental Quality, and Washington State Department of Natural Resources. November 1998.

DEQ. 2001. Guidance for Ecological Risk Assessment, Level II Screening Level Values. Oregon Department of Environmental Quality, Waste Management & Cleanup Division, Cleanup Policy & Program Development Section. Portland, Oregon. Updated December 2001.

EPA. 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. EPA/600/R-02/013. U.S. Environmental Protection Agency. Narragansett, Rhode Island, Duluth, Minnesota, and Newport, Oregon. November 2003.

Kennedy/Jenks. 2005. Astoria Area-Wide Site Ecological Risk Assessment Work Plan. Prepared for Astoria Area-Wide Potentially Responsible Party (PRP) Group. 22 September 2005.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

P. Thomas Pinit
Ecologist

Taku Fuji, Ph.D.
Senior Toxicologist/Risk Assessor

Enclosures

Table 1: Sampling Station Coordinates

Station ID	Latitude	Longitude	Approximate Depth to Mudline (ft)	Approximate Tidal Height (ft)	Approximate Depth to Mudline (ft)[(a)]
SD-100/SW-100	46° 11' 13.9" N	123° 51' 35.9" W	5	7.8	-2.8
SD-101/SW-101	46° 11' 14.1" N	123° 51' 35.9" W	2.5	6.8	-4.3
SD-102/SW-102	46° 11' 14.4" N	123° 51' 35.3" W	1.5	5.6	-4.1
SD-103	46° 11' 14.1" N	123° 51' 36.6" W	6	4.6	1.4
SD-104/SW-104	46° 11' 13.6" N	123° 51' 38.8" W	10	3.7	6.3
SW-105	46° 11' 16.1" N	123° 51' 41.7" W	22	2.7	19.3
REF-EBB	46° 11' 51.5" N	123° 48' 00.0" W	16	0.2	15.8
REF-YB	46° 10' 43.6" N	123° 54' 03.0" W	2.5	1.8	0.7

Abbreviations:

EBB = East Boat Basin
REF = Reference Sample
SD = Sediment Sample
SW = Surface Water Sample
YB = Youngs Bay

Notes:

a) Depth to mudline has been tide corrected to Columbia River Datum (CRD).

Table 2: Surface Water Chemical Analytical Results

Sample ID	Sample Date	Approximate Water Depth (ft)[a]	LPAH Compounds (µg/L)													
			Naphthalene		2-Methyl-naphthalene		Acenaphthylene		Acenaphthene		Fluorene		Phenanthrene		Anthracene	
SW-100	1/26/2006	-2.8	0.0082	J	0.0039	J	0.0018	U	0.004	J	0.0034	J	0.0092	J	0.0030	J
SW-101	1/26/2006	-4.3	0.14		0.082		0.0058	J	0.0097	J	0.0076	J	0.012	J	0.0033	J
SW-102	1/26/2006	-4.1	0.21		0.14		0.0077	J	0.015	J	0.011	J	0.015	J	0.0050	J
SW-104	1/26/2006	1.4	0.017	J	0.0095	J	0.0018	U	0.0023	J	0.0026	U	0.0048	J	0.0011	U
SW-105	1/26/2006	6.3	0.0080	J	0.0027	J	0.0018	U	0.0027	J	0.0026	U	0.0051	J	0.0013	J
EPA FCV or DEQ SLV[b]			193.5		72.16		306.9		55.85		39.3		19.13		20.73	

Table 2: Surface Water Chemical Analytical Results

Sample ID	Sample Date	Approximate Water Depth (ft)[a]	HPAH Compounds (µg/L)											
			Fluoranthene		Pyrene		Benz(a)-anthracene		Chrysene		Benzo(b)-fluoranthene		Benzo(k)-fluoranthene		Benzo(a)-pyrene	
SW-100	1/26/2006	-2.8	0.012	J	0.013	J	0.0021	U	0.0048	J	0.0032	J	0.0020	J	0.0016	U
SW-101	1/26/2006	-4.3	0.016	J	0.020	J	0.0021	U	0.0035	J	0.0029	J	0.0019	J	0.0017	J
SW-102	1/26/2006	-4.1	0.022		0.025		0.0021	U	0.0051	J	0.0020	J	0.0014	J	0.0016	U
SW-104	1/26/2006	1.4	0.0038	J	0.0030	J	0.0021	U	0.0013	U	0.0020	U	0.0014	U	0.0016	U
SW-105	1/26/2006	6.3	0.0049	J	0.0041	J	0.0021	U	0.0016	J	0.0020	U	0.0014	U	0.0016	U
EPA FCV or DEQ SLV[b]			7.109		10.11		2.227		2.042		0.6774		0.6415		0.9573	

Table 2: Surface Water Chemical Analytical Results

Sample ID	Sample Date	Approximate Water Depth (ft)[a]	HPAH Compounds (µg/L) (cont.)						Volatile Organic Compounds (µg/L)							
			Indeno(1,2,3-c,d)-pyrene		Dibenz(a,h)-anthracene		Benzo(g,h,i)-perylene		Benzene		Toluene		Ethylbenzene		Xylene	
SW-100	1/26/2006	-2.8	0.0021	U	0.0017	U	0.0037	U	0.14	U	0.12	J	0.13	U	0.22	U
SW-101	1/26/2006	-4.3	0.0030	J	0.0022	J	0.0037	U	0.61		2.7		0.47	J	2.64	
SW-102	1/26/2006	-4.1	0.0021	U	0.0017	U	0.0037	U	0.89		3.9		0.68		3.7	
SW-104	1/26/2006	1.4	0.0021	U	0.0017	U	0.0037	U	0.14	U	0.12	J	0.13	U	0.22	U
SW-105	1/26/2006	6.3	0.0021	U	0.0017	U	0.0037	U	0.14	U	0.11	U	0.13	U	0.22	U
EPA FCV or DEQ SLV[b]			0.275		0.2825		0.4391		130		9.8		7.3		13	

Abbreviations:

BTEX = Benzene, Toluene, Ethylbenzene, and Xylene.
DEQ = Oregon Department of Environmental Quality.
EPA = Environmental Protection Agency.
FCV = Final Chronic Value.
HPAH = Heavy Polynuclear Aromatic Hydrocarbon.
J = Detected concentration was below the laboratory method reporting limit and above the method detection limit.
LPAH = Light Polynuclear Aromatic Hydrocarbon.
SLV = Screening Level Value.
SW = Surface Water Sample.
U = Concentration was below the laboratory method detection limit.

Notes:

a) Depth to mudline has been tide corrected to Columbia River Datum (CRD).
b) EPA FCV for chronic toxicity of individual PAHs in water exposures, or DEQ SLV for BTEX for aquatic organisms in surface water.

Table 3: Sediment Physical Characteristics

				Conventional Sediment Parameters					Grain Size	
Sample ID	Sample Date	Approximate Water Depth (ft)[a]	Sample Depth (cm)	Ammonia (mg/kg)	Total Solids (%)	Total Volatile Solids (%)	Total Organic Carbon (TOC) (%)	Total Sulfide (mg/kg)	Percent Sand/Gravel	Percent Silt/Clay
SD-100	1/26/2006	-2.8	0-10	21.4	46.5	6.48	2.60	1,030	29.1	73.5
SD-101	1/26/2006	-4.3	0-10	69.0	40.9	10.3	4.45	1,540	18.8	82.8
SD-102	1/26/2006	-4.1	0-10	16.6	27.1	29.2	15.6	699	54.8	50.5
SD-103	1/26/2006	1.4	0-10	66.8	43.7	6.77	2.39	2,340	9.9	87.0
SD-104	1/26/2006	6.3	0-10	47.9	45.1	6.42	2.04	1,620	8.2	94.4
REF-EBB	1/26/2006	15.8	0-10	43.3	49.0	5.46	1.72	1,320	13.7	87.3
REF-YB	1/26/2006	0.7	0-10	40.5	56.5	4.91	1.36	447	35.0	68.2

Notes:

a) Depth to mudline has been tide corrected to Columbia River Datum (CRD).

Table 4: Sediment Chemistry Results

Sample ID	Sample Date	Approximate Water Depth (feet)[a]	Sample Depth (cm)	Grain Size		Metals (mg/kg)							
				Percent Sand/Gravel	Percent Silt/Clay	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Silver	Zinc
SD-100	1/26/2006	-2.8	0-10	29.1	73.5	3.34	0.42	13.2	**21**	14.4	0.073	0.117	72.2
SD-101	1/26/2006	-4.3	0-10	18.8	82.8	6.97	0.498	15	**33.6**	17.8	0.1	0.122	**144**
SD-102	1/26/2006	-4.1	0-10	54.8	50.5	8.24	0.472	17.6	**55**	25.4	0.079	0.098	**218**
SD-103	1/26/2006	1.4	0-10	9.9	87.0	4.41	0.578	15	**31**	15	0.095	0.133	81.2
SD-104	1/26/2006	6.3	0-10	8.2	94.4	4.45	0.593	14.9	**27.7**	13.7	**0.12**	0.142	78.9
REF-EBB	1/26/2006	15.8	0-10	13.7	87.3	3.22	0.407	11.7	**20.9**	10.8	**0.194**	0.121	62.5
REF-YB	1/26/2006	0.7	0-10	35.0	68.2	4.8	**0.759**	15.7	**20.3**	19.4	**0.178**	0.155	85.8
DEQ SLV [b]						7	0.7	52	19	30	0.1	0.7	124

Table 4: Sediment Chemistry Results

Sample ID	Sample Date	Approximate Water Depth (feet)[a]	Sample Depth (cm)	LPAH Compounds (µg/kg)																Total LPAH	
				Naphthalene		2-Methyl-naphthalene		Acenaphthylene		Acenaphthene		Fluorene		Phenanthrene		Anthracene					
SD-100	1/26/2006	-2.8	0-10	7.1	J	2.6	U	3.1	U	2.2	U	3.7	U	280	U	310	U	310	U		
SD-101	1/26/2006	-4.3	0-10	**40**		20		350	U	250	U	420	U	**540**	JD	350	U	**600**	JD		
SD-102	1/26/2006	-4.1	0-10	**160**		**60**		520	U	370	U	630	U	**620**	JD	**700**	JD	**1,540**	JD		
SD-103	1/26/2006	1.4	0-10	7.0	J	8.3	J	**15**		**10**	J	**45**		**110**		**480**		**675**	J		
SD-104	1/26/2006	6.3	0-10	2.9	U	2.7	U	3.2	U	2.3	U	3.8	U	8.6	J	3.2	U	8.6	J		
REF-EBB	1/26/2006	15.8	0-10	2.7	U	2.5	U	2.9	U	2.1	U	3.5	U	4.1	J	2.9	U	4.1	J		
REF-YB	1/26/2006	0.7	0-10	2.4	U	2.2	U	2.5	U	1.8	U	3.1	U	3.7	J	2.5	U	3.7	J		
DEQ SLV [b]				35		20		6		7		21		86		47		312			

Table 4: Sediment Chemistry Results

Sample ID	Sample Date	Approximate Water Depth (feet)[a]	Sample Depth (cm)	HPAH Compounds (µg/kg)															
				Fluoranthene		Pyrene	Benz(a)-anthracene		Chrysene		Benzo(b)-fluoranthene		Benzo(k)-fluoranthene		Benzo(a)-pyrene		Indeno(1,2,3-c,d)-pyrene	
SD-100	1/26/2006	-2.8	0-10	**650**	JD	**290**	**120**		**210**		160		54		76		48	
SD-101	1/26/2006	-4.3	0-10	**2,000**	D	**570**	**240**		**710**		380		120		**160**		96	
SD-102	1/26/2006	-4.1	0-10	**4,100**	D	**1,100**	**920**		**2,500**	D	1,400	JD	300		**450**		280	
SD-103	1/26/2006	1.4	0-10	**250**		**280**	**170**		**320**		170		58		58		39	
SD-104	1/26/2006	6.3	0-10	20		22	10	J	18		15		5.8	J	11	J	8.8	J
REF-EBB	1/26/2006	15.8	0-10	12		15	6.6	J	9.3	J	11	J	5.2	U	9.3	J	7.3	J
REF-YB	1/26/2006	0.7	0-10	11		13	5.8	J	8.6	J	10		4.5	U	9.3	J	7.7	J
DEQ SLV [b]				113		152	75		107		1,800		1,800		89		600	

Table 4: Sediment Chemistry Results

Sample ID	Sample Date	Approximate Water Depth (feet)[a]	Sample Depth (cm)	HPAH Compounds (µg/kg)								Chlorinated Benzenes (µg/kg)							
				Dibenz(a,h)-anthracene		Benzo(g,h,i)-perylene		Total HPAH		Total PAH		1,2-Dichloro-benzene		1,4-Dichloro-benzene		1,2,4-Trichloro-benzene		Hexachloro-benzene	
SD-100	1/26/2006	-2.8	0-10	**11**		44		**1,663**	JD	1,663	JD	2.8	U	4.1	U	3.3	U	460	U
SD-101	1/26/2006	-4.3	0-10	**19**		74		**4,369**	D	**4,969**	JD	3.2	U	4.7	U	3.7	U	520	U
SD-102	1/26/2006	-4.1	0-10	**56**		210		**11,316**	JD	**12,856**	JD	4.8	U	7.1	U	5.6	U	780	U
SD-103	1/26/2006	1.4	0-10	**8.4**	J	32		**1,385**	J	**2,060**	J	3.0	U	4.4	U	3.5	U	4.9	U
SD-104	1/26/2006	6.3	0-10	4.9	U	9.3	J	120	J	128.6	J	2.9	U	4.3	U	3.4	U	4.7	U
REF-EBB	1/26/2006	15.8	0-10	4.5	U	7.8	J	78.3	J	82.4	J	2.7	U	3.9	U	3.1	U	4.3	U
REF-YB	1/26/2006	0.7	0-10	3.9	U	9.3	J	74.7	J	78.4	J	2.4	U	3.4	U	2.7	U	3.8	U
DEQ SLV[b]				6		670		665		1,684		13		110		5		6	

Table 4: Sediment Chemistry Results

Sample ID	Sample Date	Approximate Water Depth (feet)[a]	Sample Depth (cm)	Phthalate Esters (µg/kg organic carbon)														Misc. Extractable Compounds (µg/kg)									
				Dimethyl phthalate		Diethyl phthalate		Di-n-butyl phthalate		Butyl benzyl phthalate		Bis(2-ethylhexyl)-phthalate		Di-n-octyl phthalate		Dibenzo-furan		Hexachloro-butadiene		N-nitroso-diphenylamine		PCB Aroclors	
SD-100	1/26/2006	-2.8	0-10	3.9	U	7.6	U	560	U	3.3	U	140	J	28		2.8	U	3.1	U	4.8	U	**46**	
SD-101	1/26/2006	-4.3	0-10	450	U	860	U	640	U	5.0	U	120	J	**100**		320	U	3.5	U	540	U	**58**	
SD-102	1/26/2006	-4.1	0-10	670	U	1,300	U	960	U	5.6	U	160	J	4.5	U	480	U	5.2	U	820	U	**135**	
SD-103	1/26/2006	1.4	0-10	4.2	U	8.1	U	6.0	U	3.5	U	18	J	2.8	U	16		3.3	U	5.1	U	17.5	J
SD-104	1/26/2006	6.3	0-10	4.0	U	7.8	U	5.8	U	3.4	U	7.6	J	2.7	U	2.9	U	3.2	U	4.9	U	6.1	J
REF-EBB	1/26/2006	15.8	0-10	3.7	U	7.2	U	5.4	U	3.1	U	6.1	J	2.5	U	2.7	U	2.9	U	4.5	U	3.3	U
REF-YB	1/26/2006	0.7	0-10	3.2	U	6.2	U	4.7	U	2.7	U	3.7	J	2.2	U	2.4	U	2.5	U	3.9	U	**23**	J
DEQ SLV [b]				6		6		58		63		1,300		61		110		1		28		22	

Table 4: Sediment Chemistry Results

Sample ID	Sample Date	Approximate Water Depth (feet)[a]	Sample Depth (cm)	(µg/L) Porewater Tri-n-butyltin		Ionizable Organic Compounds (µg/kg) Phenol		2-Methyl-phenol		4-Methyl-phenol		2,4-Dimethyl-phenol		Pentachloro-phenol		Benzyl alcohol		Benzoic acid	
SD-100	1/26/2006	-2.8	0-10	0.065	JD	15	J	7.4	U	6.3	U	12	U	1,900	U	8.0	U	210	U
SD-101	1/26/2006	-4.3	0-10	0.081	JD	11	J	8.4	U	22		14	U	2,100	U	9.1	U	240	U
SD-102	1/26/2006	-4.1	0-10	0.058	JD	19	J	13	U	25		21	U	3,200	U	14	U	360	U
SD-103	1/26/2006	1.4	0-10	0.028	JD	7.0	J	7.8	U	8.7	J	13	U	20	U	8.5	U	220	U
SD-104	1/26/2006	6.3	0-10	0.013	J	8.6	J	7.6	U	6.5	U	13	U	19	U	8.3	U	220	U
REF-EBB	1/26/2006	15.8	0-10	0.013	J	8.0	J	7.0	U	6.0	U	12	U	18	U	7.6	U	200	U
REF-YB	1/26/2006	0.7	0-10	0.010	J	5.5	J	6.1	U	5.2	U	9.8	U	16	U	6.6	U	170	U
DEQ SLV [b]				0.15 [c]		130		8		100		18		17		52~57		65	

Abbreviations:
µg/kg = micrograms per kilogram.
cm = centimeter.
DEQ = Oregon Department of Environmental Quality.
EBB = East Boat Basin.
ft = feet.
HPAH = heavy polycyclic aromatic hydrocarbon.
LPAH = light polycyclic aromatic hydrocarbon.
mg/kg = miligrams per kilogram.
PAH = polycyclic aromatic hydrocarbon.
PSDDA = Puget Sound Dredge Disposal Analysis.
REF = Reference Sample.
SD = Sediment Sample.
SLV = Screening Level Value.
YB = Youngs Bay.

Notes:
a) Depth to mudline has been tide corrected to Columbia River Datum (CRD).
b) DEQ SLV for marine/estuarine sediment.
c) PSDDA screening level for tri-n-butyltin in sediment porewater.
D = PAHs were diluted by a factor of 100, and tri-n-butyltin was diluted by a factor of 4 to obtain concentration.
J = Estimated concentration was less than the method reporting limit (MRL) and greater than or equal to the method detection limit (MDL).
U = Analyte concentration was not detected at or above the MRL/MDL.
Bold indicates an exceedance of the DEQ SLV for marine/estuarine sediment.

Table 5: Summary of Acute 10-Day Amphipod Mortality Bioassay Results

Sample	Test Mean Mortality (M_T) (%)	Reference Mean Mortality (M_R) (%)	$M_T - M_R$	One-Hit Criteria[a] ($M_T - M_R > 30\%$) (Pass/Fail)	Two-Hit Criteria[b] (significant difference between MT and MR) (Yes/No)	Bulk Interstitial Salinity (ppt)
SD-100	100	TBD	TBD	TBD	TBD	1.5
SD-101	100	TBD	TBD	TBD	TBD	3.0
SD-102	100	TBD	TBD	TBD	TBD	1.0
SD-103	61.0	TBD	TBD	TBD	TBD	4.5
SD-104	24.0	TBD	TBD	TBD	TBD	5.0
REF-EBB	23.0	--	--	--	--	5.0
REF-YB	61.0	--	--	--	--	7.0
Neg. Control	1.0	--	--	--	--	--

Notes:

a) One hit required to fail bioassay.

b) Two hits required to fail bioassay - to be determined (TBD) by analytical laboratory

Table 6: Summary of Chronic 20-Day Juvenile Polychaete Survival and Growth Bioassay Results

Sample	Test Mean Growth Rate (G_T)	Reference Mean Growth Rate (G_R)	G_R x 50%	One-Hit Criteria[a] ($G_T < G_R$ x 50%) (Pass/Fail)	Two-Hit Criteria[b] (significant difference between G_T and G_R) (Yes/No)
SD-100	0.74	TBD	TBD	TBD	TBD
SD-101	0.79	TBD	TBD	TBD	TBD
SD-102	0.83	TBD	TBD	TBD	TBD
SD-103	0.73	TBD	TBD	TBD	TBD
SD-104	0.80	TBD	TBD	TBD	TBD
REF-EBB	0.79	--	--	--	--
REF-YB	1.09	--	--	--	--
Neg. Control	1.03	--	--	--	--

Notes:

a) One hit required to fail bioassay.

b) Two hits required to fail bioassay - to be determined (TBD) by analytical laboratory.

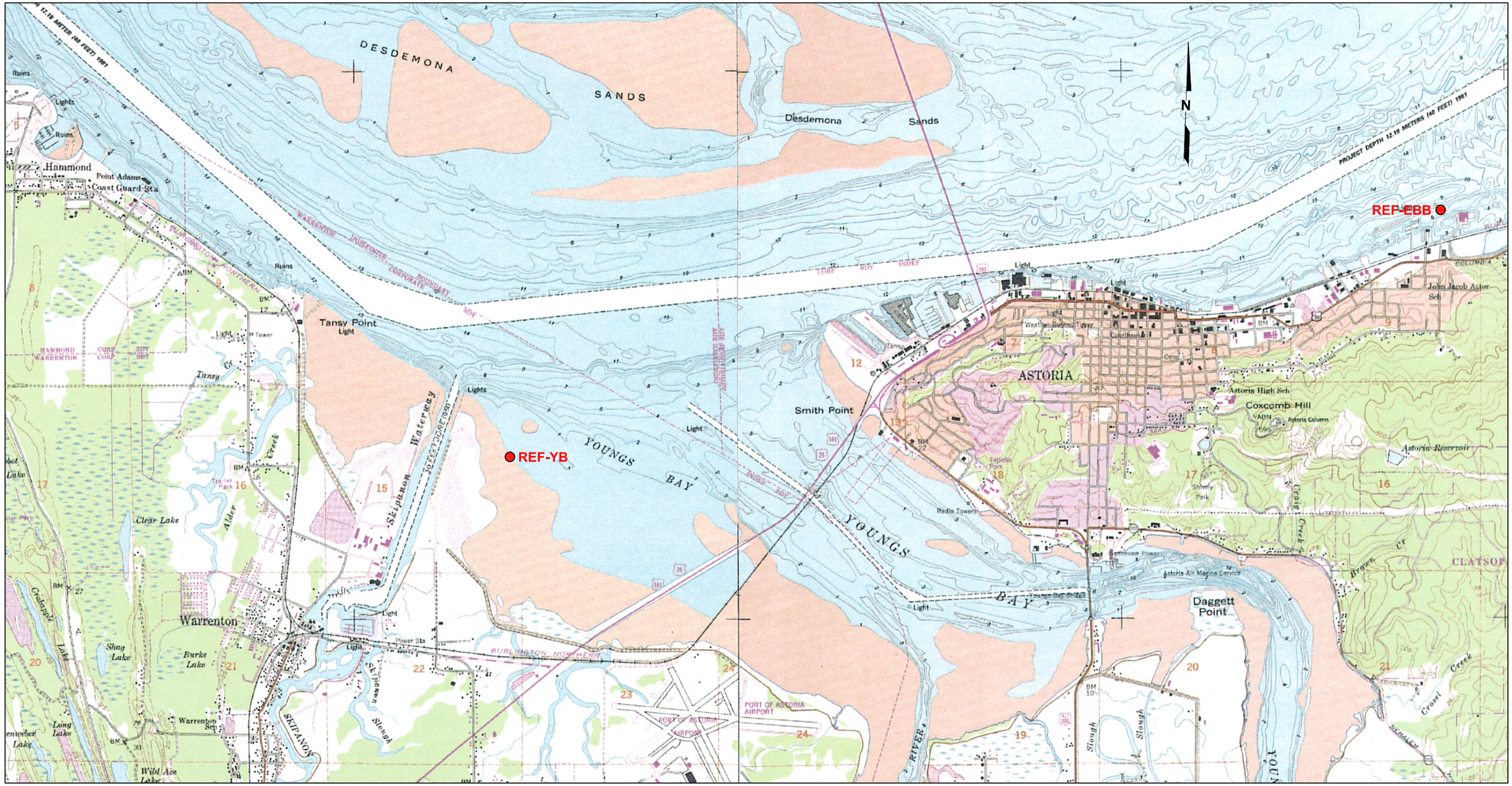
Table 7: Summary of Acute 48-Hour Larval Combined Mortality and Abnormality Bioassay Results

Sample	Test Mean NCMA (N_T) (%)	Reference Mean NCMA (N_R) (%)	N_R + 30%	One-Hit Criteria[a] ($N_T > N_R$ + 30%) (Pass/Fail)	Two-Hit Criteria[b] (significant difference between BT and BR) (Yes/No)
SD-100	80.2	TBD	TBD	TBD	TBD
SD-101	87.3	TBD	TBD	TBD	TBD
SD-102	56.4	TBD	TBD	TBD	TBD
SD-103	79.1	TBD	TBD	TBD	TBD
SD-104	77.1	TBD	TBD	TBD	TBD
REF-EBB	61.8	--	--	--	--
REF-YB	52.0	--	--	--	--
SW Control	0.0	--	--	--	--

Notes:

a) One hit required to fail bioassay.

b) Two hits required to fail bioassay - to be determined (TBD) by analytical laboratory.



LEGEND :

REF-EBB ● REFERENCE SEDIMENT SAMPLE

1,500 0 3,000

Approximate Scale in Feet

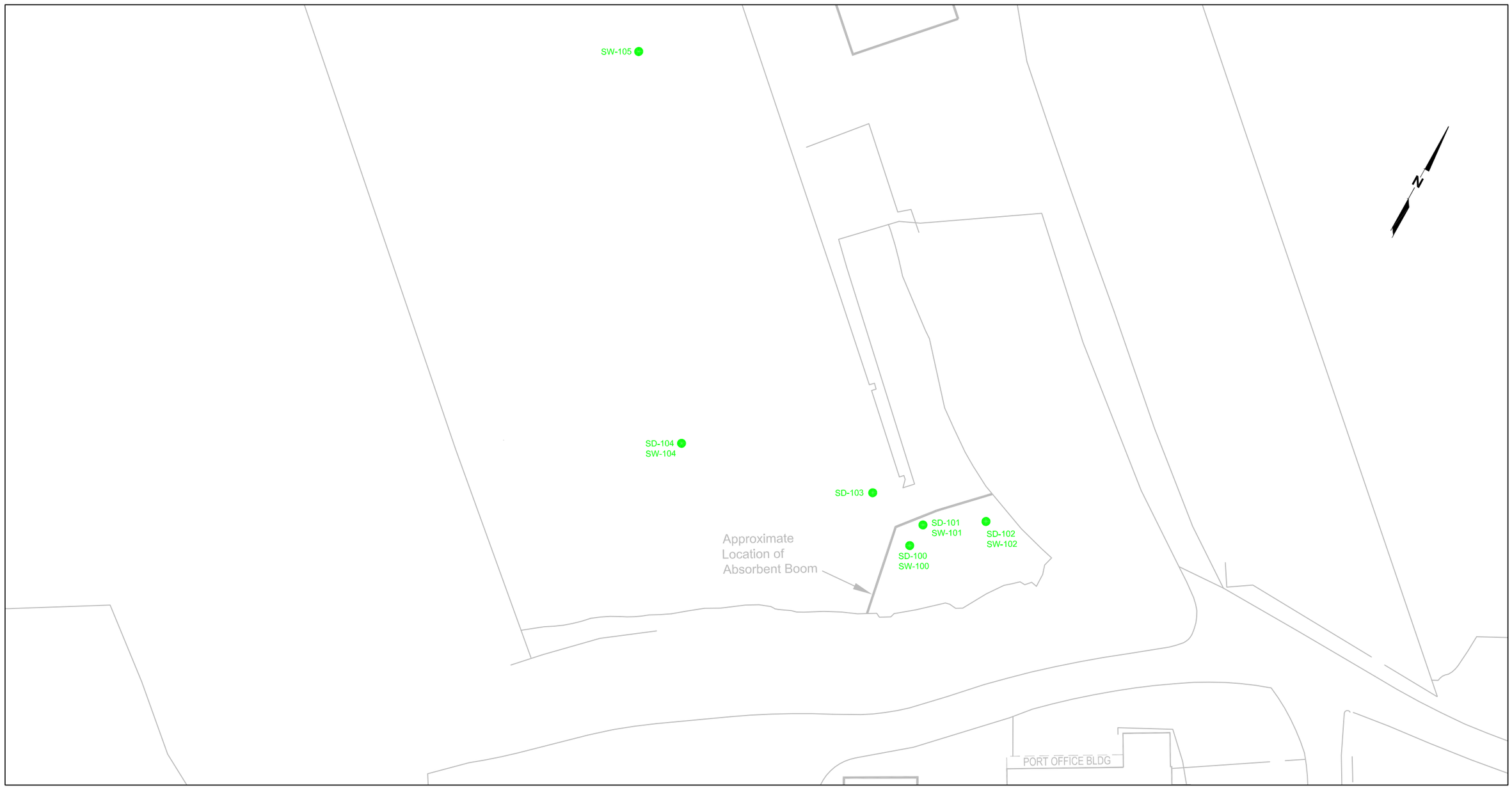
Kennedy/Jenks Consultants

ECOLOGICAL RISK ASSESSMENT
ASTORIA, OREGON

REFERENCE SEDIMENT STATIONS

Figure 1
K/J 0592004.00

Q:\Projects\05pro\0592004.00_Astoria Area-Wide PRP Group\09 - ERA Report\Figures\0592004_00 - FIGURE 1.dwg May 02, 2006 - 11:38am



LEGEND :

SD-101 SURFACE SEDIMENT SAMPLE
SW-101 WATER COLUMN SAMPLE

Notes:
1. Base map prepared from AutoCAD file provided by EnviroLogic Resources, Inc., dated 5/02.

40 0 80
Scale in Feet

Kennedy/Jenks Consultants

ECOLOGICAL RISK ASSESSMENT
ASTORIA, OREGON

SLIP 2 SAMPLING STATIONS

Figure 2
K/J 0592004.00

Q:\Projects\05pro\0592004.00_Astoria Area-Wide PRP Group\09 - ERA Report\Figures\0592004_00 - FIGURE 2 - REV1.dwg May 02, 2006 - 8:22am